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Research

Elevated Atmospheric CO_2 May Help Coastal Wetlands Keep Pace with Sea-Level Rise

By Karen L. McKee

Increases in atmospheric concentrations of the greenhouse gas carbon dioxide (CO_2) may help low-lying coastal marshes keep up with rising sea level by stimulating plant-root production, causing upward expansion of soil surfaces.

According to the Intergovernmental Panel on Climate Change (IPCC), higher CO_2 concentrations in the atmosphere are primarily responsible for recent global warming, which contributes to sea-level rise through thermal expansion of oceans and melting of ice fields. To avoid submergence, coastal marshes must match sea-level rise by building vertically—through either surface deposition of mineral sediment or accumulation of organic matter by plants.

Previous work on how coastal wetlands keep up with sea-level rise has emphasized physical processes such as sedimentation and erosion. However, plants and their contribution of organic matter are important to marsh building, especially in sediment-starved areas such as the Mississippi River Delta, according to two recent studies funded by the U.S. Geological Survey (USGS) and published in the *Journal of Ecology* and the *Proceedings of the National Academy of Sciences*.

"We knew that biological processes were important in maintaining surface elevations in other peat-forming wetlands, such as mangroves," said **Karen McKee**, a USGS ecologist. She had previously shown that belowground production of roots by mangroves, a tropical coastal tree, led to a buildup of peat over thousands of years as sea level rose by several meters. "Caribbean islands off the coast of Belize have existed for about 8,000 years and have accumulated over 10 vertical

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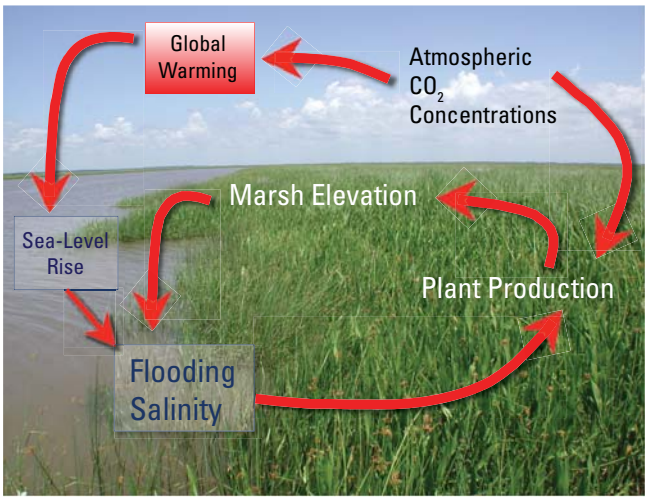
Cross section of a marsh core showing prolific accumulation of plant roots that contribute to upward expansion of marsh surfaces.

***Julie Cherry** (University of Alabama) measuring elevation change of a brackish marsh in the Mississippi River Delta.*



View of a brackish marsh in the Mississippi River Delta, with a simplified diagram showing how biological processes influence marsh elevation relative to sea level. Plant production contributes organic matter, causing upward expansion of the soil surface. As marsh elevation changes, flooding and salinity regimes also change and have a feedback effect on plant production. Increases in CO_2 concentration contribute to global warming and sea-level rise but also stimulate plant production, leading to faster gains in elevation.

Sound Waves

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Publications: When new publications or products are released, please notify the editor with a full reference and a bulleted summary or description.
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Research, continued

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meters [33 ft] of peat—the equivalent of a three-story building," said **McKee**. More information about this work appears in *Global Ecology and Biogeography* (v. 16, p. 545-556, URL **http://dx.doi.org/10.1111/j.1466-8238.2007.00317.x**)

The recent studies examined processes controlling elevations in coastal marshes in the Mississippi River Delta and the Chesapeake Bay—two areas particularly vulnerable to sea-level rise. The scientists hypothesized that rising levels of atmospheric CO_2, which is known to stimulate plant growth, might boost the buildup of marsh elevation, helping to counterbalance sea-level rise.

Both studies were based in part on research conducted in the Wetland Elevated CO_2 Experimental Facility, a USGS facility at the National Wetlands Research Center (NWRC) in Lafayette, Louisiana. The facility is designed to investigate the impacts of CO_2 and other climate-change factors on wetlands. The marsh studies are part of a larger project funded by the USGS Global Change Research Program.

McKee collaborated with **Jim Grace** (NWRC) and **Julia Cherry** (former USGS postdoctoral scientist who is currently an assistant professor at the University of Alabama) to examine the responses of a brackish-marsh community to combinations of CO_2, flooding, and salinity by using mesocosms—miniature marshes made of segments of marsh from the Mississippi River Delta and established in the greenhouses of the Wetland Elevated CO_2 Experimental Facility. The investigators varied the CO_2 concentration in each greenhouse; within each mesocosm, they varied salinity and simulated various levels of flooding.

"We found that higher concentrations of CO_2 ameliorated salt stress for one of the plant species in this brackish-marsh community, and better plant growth drove faster soil expansion in mesocosms," said **McKee**.

The data from this experiment were used to develop a model to better understand the biophysical mechanisms controlling vertical marsh expansion. "Our work shows that it's important to include biological feedback mechanisms in models used to predict inundation of coastal areas under sea-level rise scenarios," said **Grace**, whose expertise is in modeling and analysis of complex systems. Their results were reported in the January 2009 issue of the *Journal of Ecology* (v. 97, no. 1, p. 67-77, URL **http://dx.doi.org/10.1111/j.1365-2745.2008.01449.x**)

The second study, funded in part by the USGS, was led by the Smithsonian Environmental Research Center (SERC). **McKee** and **Cherry** worked with **Adam Langley** (SERC), **Pat Megonigal** (SERC), and **Don Cahoon** (USGS) to examine elevation response to CO_2 in a Chesapeake Bay marsh. The authors observed that higher CO_2 concentrations increased the rate of marsh elevation gain, primarily by stimulating plant-root production.

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Field crew collecting plant material from a brackish marsh for greenhouse experiments on how CO_2 concentration affects marsh building.

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"By combining the results of this field study with findings from the NWRC mesocosm experiment, we were able to show that the CO_2 effect observed under current sea-level conditions in the Chesapeake Bay marsh would vary depending on salinity and flooding conditions associated with future sea-level rise," said **McKee**. The Chesapeake Bay study was reported in an article titled "Elevated CO_2 Stimulates Marsh Elevation Gain, Counterbalancing Sea-Level Rise," published in the April 14, 2009, issue of *Proceedings of the National Academy of Sciences* (v. 106, no. 15, p. 6182-6186, URL **http://dx.doi.org/10.1073/pnas.0807695106**).

Wetland loss is a severe problem along parts of the U.S. coast. In some areas of coastal Louisiana, for example, wetland-building processes no longer keep pace with wetland loss, owing to a combination of factors such as sea-level rise, ground subsidence, and dams and levees that prevent coastal wetlands from receiving the river water, nutrients, and sediment needed to nourish wetland vegetation. (For example, see "Slowing of Coastal Subsidence Is Good News for Restoration of Louisiana's Wetlands," *Sound Waves*, October 2008, URL **http://soundwaves.usgs.gov/2008/10/research.html**). The insights gained from the NWRC studies described here, as well as other investigations conducted by the USGS, will contribute to a better understanding of how wetlands may respond to rising sea level and related factors. Such research will be essential to accurately predict how global climate change will impact coastal areas in the future.

*Views of the Wetland Elevated CO_2 Experimental Facility at the USGS National Wetlands Research Center in Lafayette, Louisiana. Inset photographs courtesy of **Jill Rooth** (formerly USGS, now with Science Applications International Corp. [SAIC]).*

Effects of elevated levels of atmospheric CO_2 and simulated sea-level rise on marsh-building rates were measured in mesocosms, which are miniature marshes created with plants and soil collected from the field.

Erosion Doubles Along Part of Alaska's Arctic Coast—Cultural and Historical Sites Lost

By Catherine Puckett, Helen Gibbons, Benjamin Jones, and Maria-Jose Viñas (American Geophysical Union)

The rate of coastal erosion more than doubled in Alaska—to as much as 45 feet per year—within the 52-year period between 1955 and 2007 along a 37-mile stretch of the Beaufort Sea, with ice-rich coastal bluffs showing the greatest increase in recent erosion rates.

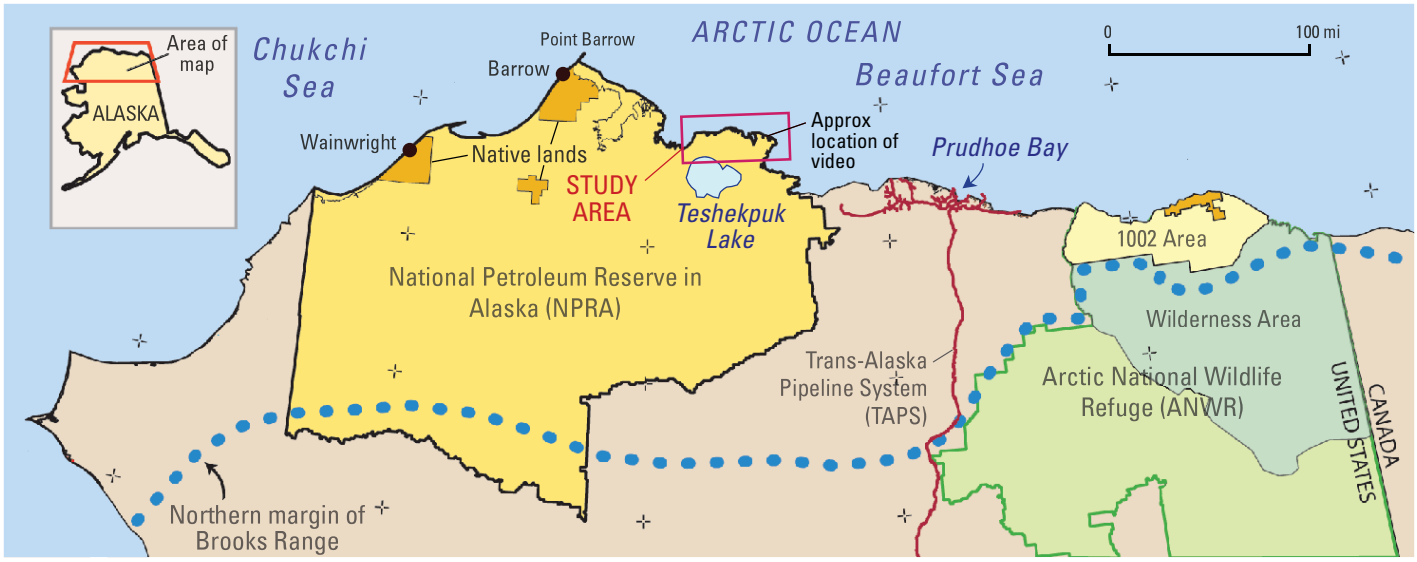
A study led by the U.S. Geological Survey (USGS) Alaska Science Center reveals that average annual erosion rates along this part of the Beaufort Sea—north of a large lake named Teshekpuk and about 100 mi west-northwest of Prudhoe Bay—climbed from historical levels of about 20 feet per year between the mid-1950s and late-1970s, to 28 feet per year between the late-1970s and early 2000s, to 45 feet per year between 2002 and 2007. The authors also observed that spatial patterns of erosion have become more uniform across shorelines with different degrees of ice richness. Until 2002, erosion rates were highest on shorelines with relatively low ground-ice content; but from 2002 to 2007, the greatest increase in erosion rates occurred for ice-rich terrain, suggesting a fundamental shift in the dominant processes driving and resisting erosion. The study was published in *Geophysical Research Letters*, a publication of the American Geophysical Union.

*USGS researcher **Benjamin Jones** measures erosion along part of Alaska's Arctic coast. On left is an example of a collapsed block of ice-rich permafrost. Photograph by **Christopher Arp**, USGS.*

The authors propose that the shifts in the rate and pattern of land loss along this segment of coastline are likely the result of changing Arctic conditions, including declining sea-ice extent, increasing summertime sea-surface temperature, rising sea level, and increases in storm power and corresponding wave action.

"Taken together, these factors may be leading to a new regime of ocean-land interactions that are repositioning and reshaping the Arctic coastline," wrote USGS research geographer and lead author **Benjamin Jones** and his colleagues. The authors noted that any increase in the current

(Arctic Erosion continued on page 5)



*Northern Alaska, showing location of segment of the Beaufort Sea coast studied by **Jones** and his coauthors. Modified from figure 1 of USGS Fact Sheet 045-02, "U.S. Geological Survey 2002 Petroleum Resource Assessment of the National Petroleum Reserve in Alaska (NPRA)."*

(Arctic Erosion continued from page 4)

rates of coastal retreat will have further ramifications for Arctic landscapes—including impacts on important freshwater and terrestrial wildlife habitats and subsistence grounds for local communities, possible effects on the global carbon budget through the release of organic carbon previously frozen in permafrost, adverse impacts on coastal villages and towns, threats to resource-extraction infrastructure (one test well has already been lost), and the loss of cultural sites that provide a record of human settlement in the Arctic.

In another recent study along the same stretch of the Beaufort Sea, **Jones** and his coauthors verified "disappearing" cultural and historical sites, including Esook, a hundred-year-old trading post now underwater on the Beaufort Sea floor, and Kolovik (Qalluvik), an abandoned Inupiaq village site that may soon be lost. At another site, near Lonely, Alaska, **Jones** snapped a picture of a wooden whaling boat that had rested on a bluff overhanging the ocean for nearly a century. A few months later, the boat had been washed away to sea. This study was published in the December 2008 issue of the journal *Arctic*.

Arctic climate change is leading to rapid and complex environmental responses in both terrestrial and marine ecosystems that will almost certainly affect the rate and pattern of Arctic coastline erosion. "For example," said **Jones**, "the recent trends toward warming sea-surface temperatures and rising sea-level may act to weaken the permafrost-dominated coastline through preferential thaw of extremely ice-rich coastal bluffs, and may potentially explain the disproportionate increase in erosion along ice-rich coastal bluffs relative to ice-poor coastal bluffs that we documented in our study."

Ice-rich bluff photographed in early September 2007, during a period of mild, persistent easterly winds. Despite the absence of westerly storms, traditionally believed to drive coastal erosion in this region, waves were undermining the bluff at this time, as shown in video clip posted at URL ***http://soundwaves.usgs.gov/2009/05/research2.html****. Photograph by* ***Christopher Arp****; video by* ***Benjamin Jones****.*

The authors also documented sections of coastline that eroded more than 80 ft during 2007. Interestingly, summer 2007 had no westerly storms, traditionally believed to be the drivers of coastal erosion in this region of the Arctic; however, 2007 did have the lowest Arctic sea-ice extent on record and relatively warm ocean temperatures.

"Erosion of coastlines is a natural process," said **Jones**, "and this segment of coastline has historically eroded at some of the highest rates in the circum-Arctic, and so the changes occurring on this open-ocean coast might not be occurring in other Arctic coastal settings." Shoreline change along the entire U.S. Beaufort Sea coast is currently being investigated by another USGS team headed by geologists **Bruce Richmond** and **Ann Gibbs** of the USGS Pacific Science Center in Santa Cruz, California, as part of a multiyear assessment of shoreline erosion and accretion along all U.S. coastlines (see "The Shrinking Beaufort Sea Coastline," this issue). **Richmond** and **Gibbs** began studying the Beaufort Sea coast in 2006 by collecting oblique aerial photographs and video footage from a small floatplane (see "North to Alaska—an Aerial Shoreline Reconnaissance" in *Sound Waves*, October 2006, URL **http://soundwaves.usgs.gov/2006/10/fieldwork2.html**). The imagery collected during that reconnaissance study was recently published as USGS Data Series 436 (URL **http://pubs.usgs.gov/ds/436/**). **Richmond** and **Gibbs** are now analyzing historical maps and photographs of the Beaufort Sea coast and digitizing the data in a consistent format that will allow comparison with data from future surveys, as well as from other U.S. coastlines. Preliminary results suggest that erosion in the Prudhoe Bay area has also been accelerating but at a much slower rate than the erosion documented north of Teshekpuk Lake by **Jones** and his colleagues.

Jones, **Richmond**, and **Gibbs** will all be working along Alaska's Arctic coast this summer, as will coastal engineer **Li**

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A cabin along Alaska's Arctic coast was recently washed into the ocean because the bluff it was sitting on eroded away. Photograph by ***Benjamin Jones****, USGS.*

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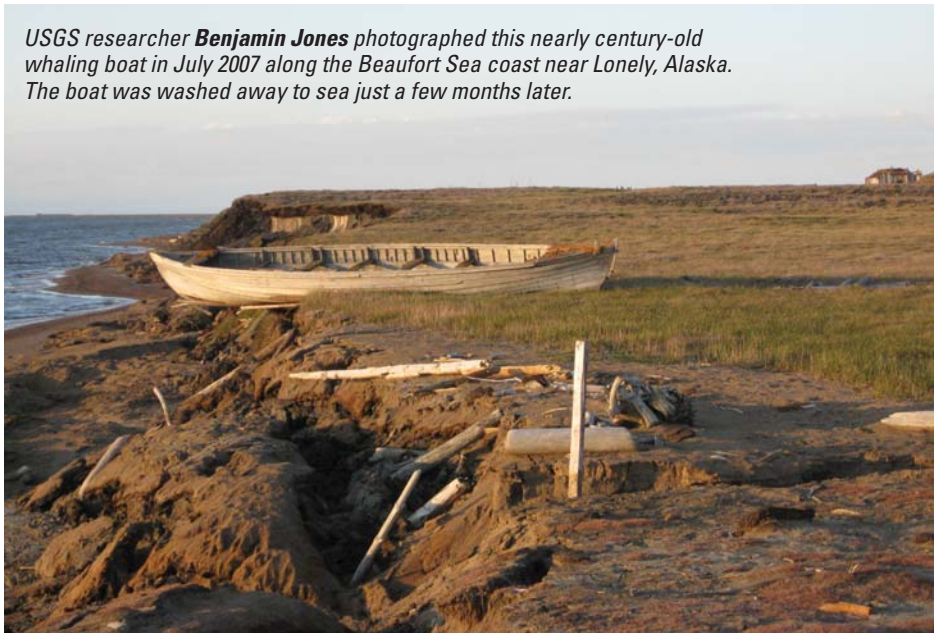
Erikson, currently a USGS Mendenhall Postdoctoral Research Fellow at the USGS Pacific Science Center. **Richmond** and **Gibbs** will work with a team that is collecting airborne-lidar (light detection and ranging) land-elevation data that can be used to document the position of the modern shoreline and to estimate the input of sediment and organic carbon as a result of rapid erosion along the Beaufort Sea coast. **Jones** and others from the Alaska Science Center will continue collecting ground-based data, some of which will provide control points for the airborne-lidar data. **Erikson** will initiate a focused physical-processes and modeling study on the Chukchi Sea coast between Barrow and Wainwright to better understand the primary factors driving coastal change in the Arctic. She will collect wave, current, salinity, and temperature measurements near the seabed in about 10 m of water at two sites; and bathymetry, sediment grain size in the nearshore and on the shoreface, and various material properties of the bluffs at selected areas within the region. The data she collects are anticipated to provide insight into the processes controlling coastal erosion, to serve as calibration and validation data for hydrodynamic and morphodynamic modeling, and to be a baseline for future studies. The researchers will share their data to help build a comprehensive picture of Arctic shoreline erosion and its causes.



*USGS researcher **Benjamin Jones** photographed this nearly century-old whaling boat in July 2007 along the Beaufort Sea coast near Lonely, Alaska. The boat was washed away to sea just a few months later.*

In their recent report, **Jones** and his coauthors emphasize that scientists should continue monitoring to better understand the causes of the increased coastline erosion they documented. The paper, "Increase in the Rate and Uniformity of Coastline Erosion in Arctic Alaska," was authored by **B.M. Jones** (USGS), **C.D. Arp** (USGS), **M.T. Jorgenson** (ABR, Inc.), **K.M. Hinkel** (University of Cincinnati), **J.A. Schmutz** (USGS), and **P.L. Flint** (USGS) and published in the February 14, 2009, issue of *Geophysical Research Letters*; it can be viewed at URL **http://www.agu.org/journals/gl/gl0903/2008GL036205/**. To read more about the loss of cultural and historical sites along this coastal segment, see the December 2008 issue of *Arctic* (v. 61, no. 4, p. 361-372, URL **http://www.arctic.ucalgary.ca/index.php?page=arctic_contents**). That paper, "Modern Erosion Rates and Loss of Coastal Features and Sites, Beaufort Sea coast, Alaska," was authored by **B.M. Jones** (USGS), **K.M. Hinkel** (University of Cincinnati), **C.D. Arp** (USGS), and **W.R. Eisner** (University of Cincinnati).

The Shrinking Beaufort Sea Coastline

A USGS team is assessing changes along the North Slope coastline using historical and contemporary maps and aerial surveys

By Alan Bailey (*Petroleum News*)

[Reprinted, with permission, from the Mar. 8, 2009, issue of *Petroleum News*, v. 14, no. 10, p. 10.]

A recent paper published by geologists from the U.S. Geological Survey reported accelerating rates of Beaufort Sea coastal erosion along a 37-mile section of shoreline bluffs, north of Teshekpuk Lake, at the northeastern edge of the National Petroleum Reserve-Alaska [see "Erosion Doubles Along Part of Alaska's Arctic Coast," this issue]. The geologists said that erosion rates have increased from 6.8 meters per year pre-1979 to 13.6 meters per year in the period 2002 to 2007, with as much as 25 meters of erosion occurring in some places in 2007.

"Concurrent Arctic changes potentially responsible for this shift in the rate and pattern of land loss include declining sea ice extent, increasing summertime sea surface temperature, rising sea level, and increases in storm power and corresponding wave action," the geologists said. "Taken together these factors may be leading to a new regime of ocean-land interactions that are repositioning and reshaping the Arctic coastline."

(Beaufort Sea Erosion continued on page 7)

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Major concern

But how do the rates of erosion discovered in the relatively short stretch of coastline investigated in this particular study compare with rates elsewhere along the Beaufort Sea coast? Shoreline erosion has become a major concern for coastal communities in northern Alaska and could perhaps impact the oilfield facilities of the central North Slope at some point in the future.

A USGS team is engaged in a study of shoreline change along the entire U.S. Beaufort Sea coast, as part of a multiyear assessment of land erosion and accretion around the entire U.S. coastline, USGS geologist **Bruce Richmond** told *Petroleum News* February 25.

"Coastal land loss is an issue all around the country, and it looks like rates are accelerating," **Richmond** said.

The coastline project, involving cooperation in Alaska between various government agencies including USGS, the U.S. Bureau of Land Management, the U.S. Fish and Wildlife Service, and the Alaska Department of Natural Resources, is collecting data from a variety of sources and assembling that data in a consistent format. The idea is to develop an historic archive and then update the data every five years or so, without having to keep re-investigating earlier data, **Richmond** said.

"The USGS is trying to come up with some consistent-methodology datasets so that we can look at one part of the United States in the same way as we look at somewhere else with respect to coastal erosion," said USGS geologist **Ann Gibbs**.

And the USGS team started studying the Beaufort Sea coast around 2006.

"We actually collected oblique aerial photography and video … along the coast from a small floatplane," **Gibbs** said.

Since then the team has been using more of an office-based approach, by tracking down and compiling historical data from sources such as National Oceanic and Atmospheric Administration maps dating back as far as the 1940s, and then digitizing the data in an appropriate format.

"BP and ConocoPhillips have (also) provided us some of their imagery to use for our analysis," **Gibbs** said.

Part completed

The team is using the shoreline data to make transects every 50 meters along the coast, west from the Canadian border, including the Beaufort Sea barrier islands but excluding major sea inlets, **Richmond** said.

"We're probably about one-third of the way finished with the analysis of the historical information," **Gibbs** said.

And in the summer of 2009 the team plans to conduct an airborne Light Detection and Ranging, or LIDAR, survey along the coast to document the location of the modern shoreline and obtain accurate land elevation data. The LIDAR data will enable the team to compile an up-to-date time history of erosion along the coast by comparing the position of the current shoreline with the historic data.

A LIDAR survey uses a laser system mounted in an aircraft to make precision measurements of landforms. It has 15 to 20 centimeter vertical accuracy, **Richmond** said.

Although the analysis of historic data is still a work in progress and remains subject to technical review, preliminary results suggest that erosion in the Prudhoe Bay area has been accelerating, but that it is occurring at a much slower rate than the erosion found north of Teshekpuk Lake. In the period between 1981 and 2000, even those places with the highest erosion rates around Prudhoe Bay appear to have been losing less than 2 meters of land per year to the encroaching sea, **Gibbs** said.

Reasons for variation

However, the variation in erosion rates along the coast raises some interesting questions about why rates are higher in some places and lower in others. That is a question that the USGS geologists have yet to address, although **Richmond** speculated that the grain size of the land material may prove to be an important factor—the bluffs north of Teshekpuk Lake tend to be composed of finer grained material than the more sand-rich material found at Prudhoe Bay.

After completing its analysis of the shoreline changes, the USGS team hopes to use its video of the coastline to classify different shoreline types and then link those types to the erosion rates, **Gibbs** said.

"After we come up with the (erosion) rates, there's a whole other level of the research project to try to reason it all out," she said.❁

A well pad and pipelines near the shore on the west side of Prudhoe Bay, photographed during a 2006 USGS coastline aerial survey. Although erosion along the Beaufort Sea coast has been accelerating, rates of erosion at Prudhoe Bay appear to be relatively low.

New USGS Study Documents Rapid Disappearance of Antarctica's Ice Shelves

Possible forecast for continued Antarctic glacier loss and sea-level rise due to climate change

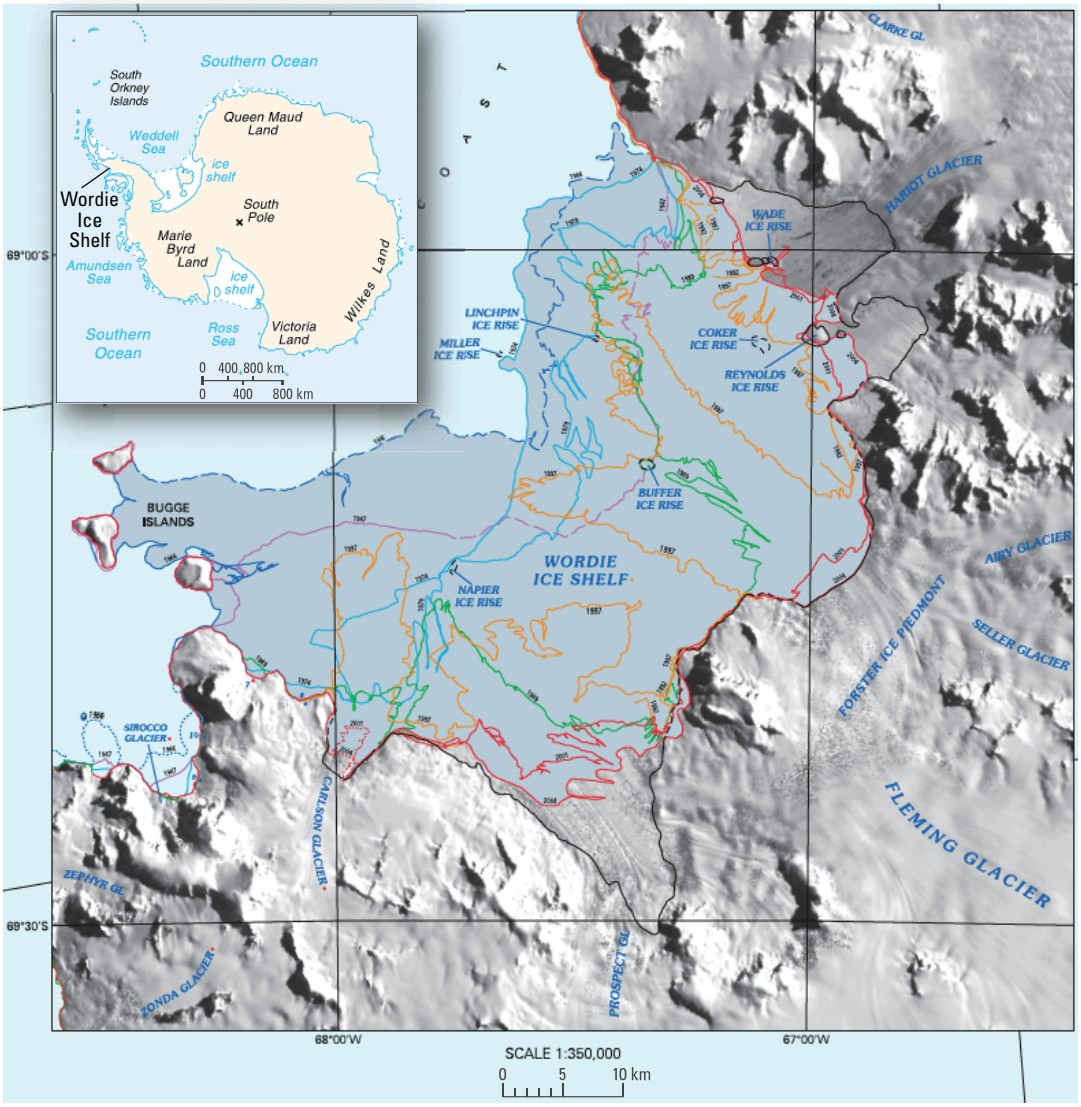
Antarctica's glaciers are melting more rapidly than previously known because of climate change, according to a new U.S. Geological Survey (USGS) report prepared in close collaboration with the British Antarctic Survey.

The USGS study documents for the first time that one ice shelf has completely disappeared and another has lost a chunk three times the size of Rhode Island. This research is part of a larger ongoing project that is for the first time studying the entire Antarctic coastline.

"This study provides the first insight into the extent of Antarctica's coastal and glacier change," noted U.S. Department of the Interior Secretary **Ken Salazar**. "The rapid retreat of glaciers there demonstrates once again the profound effects our planet is already experiencing—more rapidly than previously known—as a consequence of climate change. The scientific work of USGS, which is investigating the impacts of climate change around the world, including an ongoing examination of glaciers, is a critical foundation of the Administration's commitment to combat climate change."

The USGS study focuses on Antarctica, which is the Earth's largest reservoir of glacial ice. In a separate study published in *Geophysical Research Letters*, the National Oceanic and Atmospheric Administration reports that ice is melting much more rapidly than expected in the Arctic as well, on the basis of new computer analyses and recent ice measurements (see URL **http://dx.doi.org/10.1029/2009GL037820**).

*Excerpt from new map (URL **http://pubs.usgs.gov/imap/2600/B/**) shows extent of Wordie Ice Shelf (dark-blue shading) from 1966 (blue dashed line) to its virtual disappearance by 1974 (innermost red-orange line). Inset map of Antarctica modified from* The World Factbook, CIA*; see URL **https://www.cia.gov/library/publications/the-world-factbook/**.*



Using historical and recent satellite imagery, aerial photography, and other data, as well as the newest mapping techniques, the new USGS study, released April 3, 2009, maps recent glacier retreat along Antarctica's Larsen and Wordie Ice Shelves. It is just one of several upcoming studies of Antarctica's glaciers.

Scientists previously knew that the Wordie Ice Shelf has been retreating, but this study documents for the first time that it has completely disappeared. Moreover, the northern part of the Larsen Ice Shelf no longer exists. An area more than three times the size of the State of Rhode Island (more than 8,500 km^2) has broken off from the Larsen Ice Shelf since 1986.

USGS scientists report that these floating ice shelves are especially sensitive to climate change, so their rapid retreat may be a forecast for losses of the

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land-based ice sheet on the Antarctic continent if warming continues. This could result in sea-level rise, threatening low-lying coastal communities and islands.

"This continued and often significant glacier retreat is a wakeup call that change is happening in our Earth system and we need to be prepared," said USGS glaciologist **Jane G. Ferrigno**, lead author on the study. "Antarctica is of special interest because it holds an estimated 91 percent of the Earth's glacier volume, and change anywhere in the ice sheet poses significant hazards to society."

The new report and map of the Larsen Ice Shelf are part of a project to study the coastal change and glaciological characteristics of the entire Antarctic margin. The research is part of the USGS Glacier Studies Project that is monitoring and describing glacier extent and change over the whole planet by using satellite imagery.

The research in Antarctica is a collaborative effort of the USGS and the British Antarctic Survey, with the assistance of the Scott Polar Research Institute and Germany's Bundesamt für Kartographie und Geodäsie.

To view the report "Coastal-Change and Glaciological Map of the Larsen Ice Shelf Area, Antarctica: 1940-2005" and its accompanying map, visit URL **http://pubs.usgs.gov/imap/2600/B/**. The full reference for the report is:

Ferrigno, J.G., Cook, A.J., Mathie, A.M., Williams, R.S., Jr., Swithinbank, Charles, Foley, K.M., Fox, A.J., Thomson, J.W., and Sievers, Jörn, 2009, Coastal-change and glaciological map of the Larsen Ice Shelf area, Antarctic; 1940-2005: U.S. Geologic Investigations Series Map I-2600-B.

The other completed reports in the Coastal Change and Glaciological Maps of Antarctica series can be viewed at URL **http://pubs.usgs.gov/imap/2600/**.

Ecologists Question Effects of Climate Change on Infectious Diseases

Forum sparks debate on potential range changes in diseases

By Christine Buckley (Ecological Society of America) and Helen Gibbons

Recent research has predicted that climate change may expand the scope of human infectious diseases. A new review, however, argues that climate change may have a negligible effect on pathogens or even reduce their ranges. The paper, written by **Kevin Lafferty** of the U.S. Geological Survey's Western Ecological Research Center, has sparked debate in the ecological community.

Lafferty is a marine ecologist whose study of parasites in coastal ecosystems led him to investigate how climate change will affect the role of diseases around the world. In a forum in the April issue of *Ecology*, he suggests that instead of a net expansion in the global range of diseases, climate change may cause poleward range shifts in the areas suitable for diseases as higher latitudes become warmer and regions near the equator become too hot.

The newly suitable areas for diseases will tend to be in more affluent regions where medicines are in widespread use and can more readily combat the diseases, **Lafferty** says. He cites model estimations that the most dangerous kind of malaria will gain 23 million human hosts outside of its current range by the year 2050 but will lose 25 million in its current range.

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Senegalese gather water and do laundry in the Senegal River at Richard Toll. This is one of the most intense transmission sites known for schistosomiasis (a blood fluke transmitted by aquatic snails). In addition, nearly everyone gets malaria during the wet season. Climate change in this region is likely to increase temperatures and reduce precipitation, impacting local agriculture, while potentially decreasing transmission of schistosomiasis and malaria. But climate is not the major issue affecting disease at Richard Toll. In 1986, damming of the Senegal River for irrigation led to spectacular increases in habitat for intermediate host snails and mosquito vectors. These changes led to an explosion of disease among an immigrant population drawn to work in the new sugar cane fields. Photograph by ***Kevin Lafferty****.*

(Climate and Disease continued from page 9)

"The dramatic contraction of malaria during a century of warming suggests that economic forces might be just as important as climate in determining pathogen ranges," **Lafferty** says.

Mercedes Pascual of the University of Michigan sees the situation very differently. **Pascual** is the lead author of one of five papers published in response to **Lafferty** in the journal's "Forum" section. Although she agrees that disease expansion in some areas could be accompanied by retraction in others, she emphasizes that disease range does not always correlate with the number of humans infected. In regions of Africa and South America, for example, humans have historically settled in high latitudes and altitudes. If climate change makes these areas more fit for mosquito breeding and for pathogen development, she writes, then the number of infections could expand. She notes that scientists are already seeing evidence of this pattern.

"It would be very unfortunate if the conclusions in **Lafferty's** paper were taken as evidence that climate change does not matter to infectious diseases," **Pascual** says. "Range shifts will matter and should be better understood."

Lafferty agrees that range shifts mean there will be winners and losers among human populations. Knowing how disease ranges will shift, instead of assuming a global expansion of diseases, will be the key to distributing resources effectively, he says.

Scientists have used the fact that infectious diseases are most prevalent in the tropics to argue that warmer, wetter conditions that might occur under climate change would lead to an increase in infectious disease transmission. However, **Lafferty** points out that climate change isn't making the whole world warmer and wetter: warming trends over the past 60 years have led instead to an increase in hot, dry, desertlike climates. Furthermore, he says, infectious diseases don't all increase during warm, wet weather. Meningitis peaks during the tropical dry season, for example, and influenza is an obvious staple of winter weather in temperate climes.

Pascual argues, however, that humans have a history of altering the landscape to suit their needs and thus might unintentionally create better habitat for disease carriers. For example, humans seldom leave accessible arid areas alone; instead, they irrigate them for use as farmlands. According to **Pascual**, the creation of water sources could provide havens for mosquitoes, and thus malaria parasites, to remain in areas that would otherwise dry out.

"We live in a world in which urban and rural areas are increasingly interfacing with each other," says **Pascual**. "This underscores the challenges for predicting the Earth's changing environment."

Lafferty agrees that climate isn't the only issue that affects disease ecology, and maintains that climate may play only a small part in determining disease ranges.

"If we overemphasize the role of climate, which we have little control over, at the expense of other factors that drive disease dynamics, we may be missing the forest for the trees," he says.

The full reference for **Lafferty's** paper is: Lafferty, K.D., 2009, The ecology of climate change and infectious diseases: Ecology, v. 90, no. 4, p. 888-900, doi:10.1890/08-0079.1 [URL **http://dx.doi.org/10.1890/08-0079.1**]. The five Forum papers published in response to **Lafferty** can be accessed through links at URL **http://www.esajournals.org/toc/ecol/90/4**.❁

Science and Community Education Support Diamondback Terrapin Survival

By Ann B. Tihansky

The diamondback terrapin (*Malaclemys terrapin*), named for the pronounced bumps on the central spine of its shell, ranges from Texas to Massachusetts. It is the only turtle restricted to brackish coastal waters along the Atlantic and Gulf of Mexico coasts, and like most turtle species, its numbers are declining. The markings and coloring of diamondback terrapins are distinct and vary with habitat and region. No two are alike, but you'll be lucky to see even one.

Even for fishermen and marine scientists who frequently observe wildlife within the marshes, tidal creeks, and mangrove forests that fringe Florida's undeveloped shores, seeing a diamondback terrapin in the wild is uncommon. The turtles are well camouflaged and fast swimmers; they are inclined to hide in submerged mangrove roots or seek the deeper waters of dark tidal creeks as humans approach.

Diamondback terrapins are well camouflaged among mangrove roots.

The population status of these elusive creatures, like that of most turtles, is predominantly declining or simply unknown for the 16 coastal States where terrapins are found. In a 2004 survey conducted for the Third Workshop on the Ecology, Status, and Conservation of Diamondback Terrapins, Florida turtle researchers ranked the top threats to terrapin survival but pointed out that too few data are available to assess their status accurately. Dominant threats varied by region, but consistently topping the list

(Diamondback Terrapin continued on page 11)

(Diamondback Terrapin continued from page 10)

were death in crab traps, loss of habitat, and predation. The top recommended action was to initiate field studies.

With Florida representing 20 percent of the total terrapin habitat range, impacts and policies that affect terrapins in Florida will greatly influence the overall conservation of the species. The Florida Fish and Wildlife Conservation Commission is concerned about threats to the species, but they need better data before making any management recommendations.

"There is so much we don't know," said **Kristen Hart**, a USGS biologist who studies terrapins. **Hart** also serves as Florida Regional Representative of the Diamondback Terrapin Working Group, an association of individuals from academic, scientific, regulatory, and private organizations working to promote diamondback terrapin conservation (URL **http://www.dtwg.org/**). "The paucity of data and inconsistency of available information prevent us from being able to say anything meaningful about survival, abundance, or population dynamics. If we start now, 2009 would be our baseline, but it would help immensely if we *did* start now. Then we could develop a consistent data program that describes terrapin population trends and what causes them."

*Diamondback terrapin (*Malaclemys terrapin*); note distinctive diamond-back ridges on shell spine.*

The diamondback terrapin ranges from the coastal areas of Texas as far north as Massachusetts.

"Loss of nesting habitat, encounters with automobiles, predation, commercial harvest, and incidental drowning in crab pots" are some of the significant threats to terrapin survival, said biologist **George**

(Diamondback Terrapin continued on page 12)

Fun Facts About the Diamondback Terrapin, *Malaclemys terrapin*

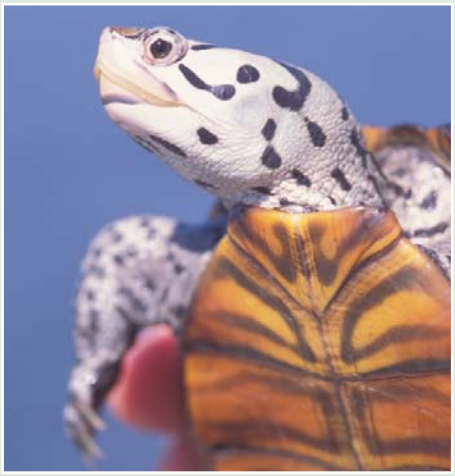
♦ Diamondback terrapins live in brackish-water salt marshes and mangroves along the Atlantic and Gulf coasts of the United States, from Cape Cod, Massachusetts, to the Texas-Mexico border.

♦ In colder climates, terrapins "brumate." (Though physiologically different from hibernation, brumation is the reptilian equivalent to sleeping through the winter.)

♦ Once mature, females are on average three times as large as males of the same age—a difference in size called sexual dimorphism. Full-grown females are about the same size as a football.

♦ Terrapins generally stay close to their home-base area—a tendency known as "high site fidelity" or "philopatry."

♦ Terrapins may live as long as 40 years or more in the wild.



♦ Terrapins have unique skin coloring and patterns—some have totally black skin, some gray skin with black spots, and still others black stripes on white skin.

♦ A terrapin can retract fully into its shell, which provides protection from sharks and raccoons.

♦ The gender of a developing baby turtle is determined by the temperature of the nest chamber—warmer temperatures produce females, whereas cooler temperatures produce males. This phenomenon is called environmental or temperature-dependent sex determination.

♦ Terrapins eat snails, mollusks, and crabs.

♦ Females must come ashore to find dry, upland substrate for egg laying.

♦ The terrapin is listed as a "species of special concern" in many States throughout its range, owing to loss of habitat and incidental capture and mortality in traps fished for blue crabs (*Callinectes sapidus*).

(Diamondback Terrapin continued from page 11)

Heinrich of Heinrich Ecological Services, who previously served as the Florida Regional Representative with the Diamondback Terrapin Working Group. While most biologists agree that habitat loss and damage to nesting habitat caused by human activity pose a grave threat to terrapins, addressing this threat presents a big challenge. Any conservation decisions made by Federal, State, or local land managers will have to be based on scientific data, which take time to gather. In the meantime, community awareness and grassroots activities may be the most effective way to protect the diamondback terrapin.

"Reaching the public is critical," said **Joseph Butler**, Senior Co-Chair of the Diamondback Terrapin Working Group and biologist at the University of North Florida. "If the public is more familiar with the natural history of terrapins and has a better understanding of the threats facing this species, people will be more likely to assist in conservation efforts." One way to reach the public is through workshops, and for the past 16 years **Heinrich** has been the primary instructor for an annual workshop focused on the natural history and conservation of Florida turtles. Building on the idea that education is the key to conservation, **Heinrich's** workshop includes field trips, resources, and activities designed for educators and conservationists who want to share their new knowledge.

At Tampa Preparatory School, turtle awareness goes back to 1976, when the terrapin was chosen as the school mascot. Then, 3 years ago, when the Alumni Association decided to come up with an activity that was fun, educational, beneficial to the community, and tied to an environmental issue, it seemed obvious to use the mascot to raise community awareness about turtles, especially the diamondback terrapin. The school's property is along the shore of the brackish-water section of the Hillsborough River in downtown Tampa, primary terrapin habitat. **Ann Tihansky**, a Tampa Prep alumna and USGS scientist, suggested that the school create a custom-designed fiberglass diamondback terrapin on wheels that could be pulled by hand and displayed as a float in the local annual Children's Gasparilla Parade. Making the turtle involved the skillful work of boat-builder **Joey Silvernail** and the artistic and production talents of **Tihansky** and **Jordan Sanford**, another USGS scientist. Together, they designed the float not only to look like a diamondback terrapin but also to be sturdy enough to use year after year.

The diamondback terrapin float is pulled along the Children's Gasparilla Parade route as part of Tampa Preparatory School's mission to share information about terrapins and other turtles.

*Students collect mangrove propagules (seeds) from the red mangrove (*Rhizophora mangle*). The propagules will be part of an artistic display while they develop roots.*

Red mangrove propagules on display in the sunny front entrance to Tampa Preparatory School.

"The parade attracts more than 250,000 people, so it's a great way to raise awareness about the school and terrapin conservation," said **Robin Kennedy**, Tampa Prep's Director of Alumni Relations and Communication. "We designed stickers that say 'Support turtle conservation; Tampa Prep does,' and our students pass them out along with plush turtles and USGS bookmarks that highlight fun facts about sea turtles, box turtles, and the diamondback terrapin. Every year we look for additional educational material that would be suitable to hand out," said **Kennedy**.

Another USGS scientist who has been participating in community education projects to benefit natural resources is **Tom Smith**, a USGS biologist specializing in mangroves. **Smith** has been collaborating with environmental artist **Xavier Cortada** in a participatory environmental art project called the Reclamation Project (URL **http://www.xaviercortada.com/?RP_index**). The project engages students from Tampa and Shorecrest Preparatory Schools, teaching them about mangroves and the important habitat that mangroves provide

(Diamondback Terrapin continued on page 13)

(Diamondback Terrapin continued from page 12)

to terrapins, as well as many other coastal wetland species.

Cortada enlists students to collect mangrove propagules (seeds) from the wild, and creates artistic installations of the seedlings in public areas while they develop roots. Once the roots are sufficiently developed, students plant the seedlings in reclamation areas. **Smith** supervises the students when they collect the mangrove propagules and again during planting. He uses data from the project to evaluate mangrove-restoration methods and looks at survival-success rates, along with other information about mangrove-forest ecology.

"Through the Reclamation Project, we give students a unique experience that many would not have otherwise," said **Cortada**, who sees many benefits for the community. "It's likely that these students will always maintain a connection to the area where they worked," said **Cortada**.

Resource-education programs like these increase community awareness and support. Both the terrapin and the community will benefit.❁

USGS Assists with Science Fairs in Falmouth, Massachusetts

By Chris Polloni

Researchers from the U.S. Geological Survey (USGS)'s Woods Hole Science Center in Woods Hole, Massachusetts, were impressed with the innovative scope of student projects in this year's science fairs in the neighboring community of Falmouth.

The 2009 science-fair activities came in three phases. Before the science fairs began, USGS personnel acted as mentors at the Lawrence School, where they assisted 6th- through 8th-grade teachers by giving students constructive criticism on project outlines and guiding them in the setup and methods of their chosen projects. Eight USGS scientists served as judges at the first fair of the year: the annual Science Fair competition at Falmouth Academy, where science projects are a core part of the school curriculum. A week later, Falmouth High School hosted the Falmouth Public Schools Science Fair, where students in grades K-12 enjoyed a wide variety of activities that included hot-air balloons (part of a physics experiment) wafting to the rafters. An inflatable whale model from Stellwagen Bank National Marine Sanctuary gave students a chance to step inside and receive a briefing from **Anne Smrcina**, a National Oceanic and Atmospheric Administration (NOAA) educator who interacts on occasion with USGS staff to develop material for outreach activities. To help inspire students to think about careers in science, **Kama Thieler**, liaison for the Woods Hole Science and Technology Education Partnership (WHSTEP), arranged for five major science institutions to have a presence at Falmouth High School. The Woods Hole Oceanographic Institution, the Sea Education Association, the Marine Biological Laboratory, the Woods Hole Research Center, and the USGS Woods Hole Science Center all displayed examples of their Earth-science work.

USGS researchers who served as mentors at the Lawrence School included **Brian Buczkowski**, **Neil Ganju**, **Claudia Flores**, **Kama Thieler**, and **Bill Waite**. Those who judged at Falmouth Academy's Science Fair were **Uri ten Brink**, **Brian Buczkowski**, **Jason Chaytor**, **Debbie Hutchinson**, **Elizabeth Pendleton**, **John Pohlman**, **Dave Twichell**, and **Bill Waite**. Participants in the Falmouth Public Schools Science Fair at Falmouth High School were **Mike Bothner**, **Jane Denny**, **Claudia Flores**, **Chris Polloni**, **Kathy Scanlon**, **Bill Waite**, **Bill Winters**, and **Chuck Worley**.❁

Students walk by a life-size inflatable whale model from Stellwagen Bank National Marine Sanctuary. ***Anne Smrcina*** *was inside the model, where one of her responsibilities was to keep students from climbing into the fins.*

USGS scientists ***Claudia Flores*** *(on left, with back to camera) and* ***Jane Denny*** *(right, partly hidden by visitor) provide detailed information about their work.*

USGS and Woods Hole Oceanographic Institution Participate in Coastal Erosion Workshop in Ghana

By Cheryl Hapke and Andrew Ashton (Woods Hole Oceanographic Institution)

Erosion is a chronic issue along the Ghanaian coastline, where high erosion rates are affecting coastal infrastructure and valuable cultural resources. Nearly 50 percent of the population of Ghana lives along the coast, and erosion rates as high as 1 m/yr have been measured near the country's capital city, Accra. The geomorphology of the coastline varies widely—from coastal lagoons with barrier beaches, to rocky cliffs fronted by narrow beaches, to a large wave-dominated deltaic system. Human intervention along the coastline has not been conducted in a systematic fashion, and attempts at erosion mitigation range from small rock revetments scattered along the coast to a large engineering project (the Keta Sea Defense) along the Volta River delta in the eastern part of the country. Large-scale infrastructure development, including damming of the Volta River and the construction of deep-water harbors, has disrupted the natural movement of sediment along the beach and nearshore (the "littoral" zone) and delivery of sediment to the coast. Researchers at the University of Ghana are in the initial stages of developing a comprehensive monitoring and assessment program to understand the processes driving coastal erosion in Ghana; however, the varying geomorphology and intermittent human modification present unique challenges to developing a systematic strategy.

The Africa Partnership Station, an international initiative supported by U.S. Naval Forces Africa, works with U.S., European, and African partners to enhance maritime safety and security on the African continent. Through funding from the Coastal Geosciences Program within the U.S. Office of Naval Research and with assistance from the Africa Partnership Station, researchers at the University of Ghana are partnering with U.S. scientists to examine and understand coastal processes, as well as to develop a monitoring network to identify future coastal hazards. As part of an initial effort, **Cheryl Hapke** from the U.S. Geological Survey (USGS) and **Andrew Ashton** from the Woods Hole Oceanographic Institution (WHOI) traveled to Ghana to meet and collaborate with scientists from the University of Ghana.

A 5-day Coastal Erosion Workshop was held February 23-27, 2009, at the Department of Oceanography and Fisheries at the University of Ghana in Accra. In addition to **Hapke** and **Ashton**, participants included faculty and graduate students from the Departments of Oceanography, Geology, and Physics at the University of Ghana, as well as researchers from Kwame Nkrumah University and several government agencies. Part of the effort was not only to meet and share information and ideas but also to visit specific field sites of interest to collect initial surveys and develop data-collection strategies. The Department of Oceanography has recently acquired real-time kinematic Global Positioning System (RTK GPS) instrumentation, and **Ashton** brought along a ground-penetrating radar (GPR) system to demonstrate how long-term coastal evolution can be recorded in the sedimentary record. Participants spent 3 days in the field at Mukwe Beach near Accra, and Ada Foah, Cape Saint Paul, and Keta in eastern Ghana. During the final day of the workshop, **Hapke** and **Ashton** met with principal investigator and Department of Oceanography Chair **George Wiafe** and faculty members

(Erosion in Ghana continued on page 15)

Coast of Ghana. The workshop was held in Accra at the University of Ghana. Field-trip and data-collection sites included a beach near Tema and several locales near Keta.

(Erosion in Ghana continued from page 14)

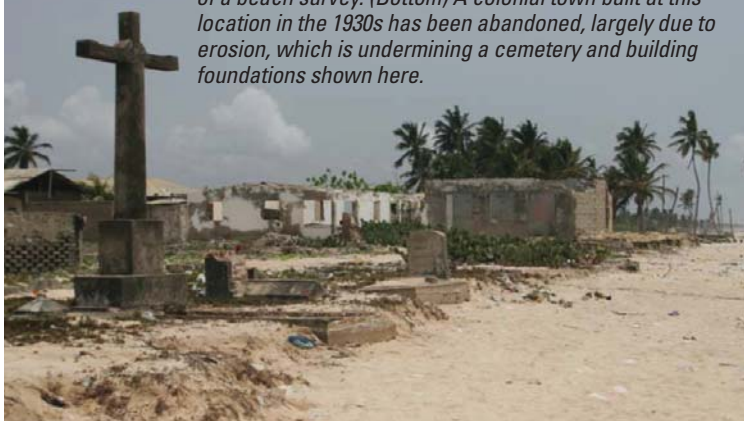
Selorm Ababio and **Appeaning Addo** to discuss specific scientific issues and directions that might lead to fruitful collaborations. The smaller group drafted an abstract about the Coastal Erosion Program at the University of Ghana that will be presented at the International Geoscience and Remote Sensing Symposium in Cape Town, South Africa, in summer 2009.

Coastal Erosion Workshop participants at the University of Ghana. ***Dr. George Wiafe*** *(front row, third from left, between* ***Andrew Ashton*** *and* ***Cheryl Hapke****) is the Chair of the Department of Oceanography and principal investigator of the Coastal Erosion Studies project at the University of Ghana.* ***Dr. Augustus Vogel*** *(back row, far left) is the Maritime Partner Liaison for the Africa Partnership Station.*

Cheryl Hapke *talks with* ***Selorm Ababio*** *(University of Ghana) about coastal-erosion issues at Mukwe Beach, near Accra. Soft bluffs composed of Quaternary sediments are eroding rapidly at this site.*

Workshop participants collect ground-penetrating radar (GPR) data under the guidance of ***Andrew Ashton*** *(second from right) at Ada Foah. The GPR data indicate a long history of beach progradation in this area, likely associated with formation of the Volta Delta. High rates of erosion in more recent times are likely due to the disruption of sediment supply caused by damming of the Volta River.*

(Top) Workshop participants set up a real-time kinematic Global Positioning System (RTK GPS) base station and roving unit at Ada Foah at the beginning of a beach survey. (Bottom) A colonial town built at this location in the 1930s has been abandoned, largely due to erosion, which is undermining a cemetery and building foundations shown here.



Hawai‘i State Senate Urges Use of USGS Findings to Preserve Health of South Moloka‘i Coral Reef

*Cover of USGS report (URL **http://pubs.usgs.gov/sir/2007/5101/**) recently honored by a concurrent resolution of support by the Hawai‘i State Senate.*

The Hawai‘i State Senate has adopted a resolution “expressing support for the United States Geological Survey report, ‘The Coral Reef of South Moloka‘i, Hawai‘i: Portrait of a Sediment-Threatened Fringing Reef,’ and encouraging Federal, State, and community cooperation to steward the South Moloka‘i fishery.” The report, USGS Scientific Investigations Report 2007-5101, has received numerous accolades since it was published November 2008.

The concurrent resolution was passed by the Hawai‘i State Senate on March 6, 2009, and is moving toward adoption in the State House of Representatives. Here are some excerpts:

“…In ancient times the people of the island of Moloka‘i were known for producing abundant quantities of food, so much so that the island and its surrounding waters were known as ‘Aina Momona,’ meaning ‘abundant land.’…. The South Moloka‘i Reef has been a key resource for the maintenance of the island’s wealth as a food producer, as evidenced by the 50-plus traditional Hawaiian fishponds that still mark its shoreline, as well as the enduring fishing traditions that continue to sustain the people of Moloka‘i…[but] modernization and abandonment of traditional resource management have led to a severe decline of Moloka‘i’s fishery…and a century of cattle grazing, goat foraging, and other land-use practices have caused severe sedimentation that negatively impacts the South Moloka‘i Reef…. In 1999, the United States Geological Survey began an indepth study of the sedimentation crisis on the South Moloka‘i Reef…culminating in the 2008 publication of a report, ‘The Coral Reef of South Moloka‘i, Hawai‘i: Portrait of a Sediment-Threatened Fringing Reef.’

“…The Legislature expresses support of the use of the scientific findings as presented in the United States Geological Survey report…and traditional Hawaiian conservation practices to preserve the health of the South Moloka‘i Reef…. The Legislature expresses its appreciation for the efforts of the United States Geological Survey scientists, researchers, and others for their innovative study of the South Moloka‘i Reef over a decade.”

The report is posted at URL **http://pubs.usgs.gov/sir/2007/5101/**, and also described in the January/February 2009 issue of *Sound Waves* (URL **http://soundwaves.usgs.gov/2009/01/pubs.html**).

DOI Meritorious Service Award for Conservation of Critical Sediment Resources in the Grand Canyon

U.S. Geological Survey (USGS) coastal and marine scientists specializing in the study of sediment transport have played a major role in research on sand in the Grand Canyon, adapting marine-science techniques and instruments to study this important resource. Their frequent collaborator, USGS hydrologist **Ted Melis**, recently won a U.S. Department of the Interior Meritorious Service Award, the second highest Departmental honor award that can be granted to a career employee. The award was celebrated at the USGS 2008 Western Region Awards Ceremony on February 24, 2009, in Menlo Park, California, where Western Region Chief Scientist **Brian Cole** read the following citation:

“As the Grand Canyon Monitoring and Research Center Program Manager for Physical Resources, **Ted Melis** has managed a wide range of studies related to conservation of critical sediment resources in the Grand Canyon of the Colorado River. He developed a comprehensive program to respond to information needs of managers and stakeholders participating in the Glen Canyon Dam Adaptive Management Program, and assembled and led a team of scientists from the USGS and academic institutions to meet those needs. **Dr. Melis** was an agency leader in developing and testing innovative laser and acoustic technologies capable of measuring sediment-transport rates at remote locations in the Colorado River in real time. This information has been critical to stakeholder deliberations and decisions related to con-

(Grand Canyon continued on page 17)

(Grand Canyon continued from page 16)

trolled floods aimed at restoring sandbars and related habitats in the Colorado River within the Grand Canyon. **Dr. Melis** has worked with managers and stakeholders to develop and evaluate operating plans for Glen Canyon Dam that have advanced scientific understanding and conservation of the Colorado River ecosystem in the Grand Canyon. He continues to provide leadership in implementing a multidisciplinary ecosystem approach to providing scientifically sound information to the Glen Canyon Dam Adaptive Management Program and to the Department of the Interior. For his outstanding contributions to the USGS in understanding and conservation of sediment resources in the Colorado River and support of the Glen Canyon Dam Adaptive Management Program, **Dr. Theodore S. Melis** is granted the Meritorious Service Award of the Department of the Interior."

***Ted Melis** (left) receives Meritorious Service Award from Western Regional Director **Anne Kinsinger**, while Western Region Chief Scientist **Brian Cole** (at podium) reads the award citation. Photograph by **Mike Diggles**, USGS.*

2008 High-Flow Experiment from Glen Canyon Dam Leads to Awards for USGS Personnel

On March 5, 2008, then-Secretary of the Interior **Dirk Kempthorne** pushed a button that opened a series of jet tubes below Glen Canyon Dam, Arizona, sending water into the Grand Canyon at a rate of about 41,500 ft^3/s, three to four times the normal release from the dam. Thus began a 60-hour high-flow experiment designed to study and improve Colorado River resources in Grand Canyon National Park.

The main goal of the experiment was to assess the ability of such releases to push sand from the bottom of the river onto sandbars along its banks, which provide habitat for wildlife and campsites for thousands of Grand Canyon National Park visitors. Grand Canyon sandbars have been shrinking since Glen Canyon Dam was built and cut off the supply of sediment from the Colorado River upstream. Most sediment entering Grand Canyon National Park now arrives from tributaries below the dam. The March 2008 high-flow experiment was timed to take advantage of large amounts of sediment delivered to the system after an unusual number of monsoonal storms. Some of the key players in the experiment have adapted marine-science equipment and techniques to investigate sand transport in the Grand Canyon. Other effects of the high flow are being studied as well, such as the well-being of the endangered humpback chub and other native fish.

*Four open jet tubes release water from Glen Canyon Dam during the 2008 high-flow experiment. Photograph by **David Walsh**, Bureau of Reclamation.*

The high-flow experiment is an interagency research effort conducted by three

(High-Flow Experiment continued on page 18)

(High-Flow Experiment continued from page 17)

Department of the Interior bureaus: the U.S. Geological Survey (USGS); the Bureau of Reclamation, which operates Glen Canyon Dam on the Colorado River; and the National Park Service (NPS), which manages Grand Canyon National Park. The experiment led to several internal and external awards for USGS personnel.

Western Region Director's Award

The USGS 2008 Western Region Director's Award, given in recognition of outstanding science accomplishments, was awarded to the "dedicated employees who have provided cutting-edge science to the Department of the Interior through the 2008 Glen Canyon Dam High-Flow Experiment." Western Region Chief Scientist **Brian Cole** announced the award at the USGS 2008 Western Region Awards Ceremony on February 24, 2009, in Menlo Park, California, calling the experiment "a remarkable scientific and logistical feat that has greatly contributed to our understanding of high-elevation sandbars, nutrient deposition, and backwater channels" and noting "This work was a significant collaborative effort with other Department of the Interior agencies, States, Tribes, and nongovernmental organizations." **Andrea Alpine**, Southwest Biological Science Center Chief, and **John Hamill**, Grand Canyon Monitoring and Research Center Chief, accepted the award on behalf of the high-flow experiment team, which includes about 2 dozen USGS scientists.

Western Region Communicator of the Year Award

The USGS Office of Communications gave its 2008 Western Region Communicator of the Year Award to **Lara Schmit**, Communications and Outreach Coordinator with the USGS Southwest Biological Science Center. This award was also presented at the February awards ceremony in Menlo Park, by then-Acting Western Region Chief of Communications **Kathleen Gohn**, who said: "In the past year, **Lara** has been at the forefront of extensive news-media activities related to the Glen Canyon Dam high-flow experiment and organizing a very successful Colorado River Science Symposium. **Lara's** work with our cooperators and partners has been critical to the success of our communications and outreach efforts. Working with the National Park Service, the Bureau of Reclamation, and other partners, she played a significant role in raising both the value and the visibility of our science."

*Southwest Biological Science Center Chief **Andrea Alpine** (far left) and Grand Canyon Monitoring and Research Center Chief **John Hamill** hold the 2008 Western Regional Director's Award, which they accepted from USGS Western Regional Director **Anne Kinsinger** (far right) on behalf of the USGS Glen Canyon Dam high-flow experiment team. Western Region Chief Scientist **Brian Cole**, in background, reads the award citation. Photograph by **Mike Diggles**, USGS.*

National Association of Government Communicator's Blue Pencil Award

The National Association of Government Communicators awarded a 2009 Blue Pencil Award of Excellence in the media-event category to the USGS for the 2008 high-flow experiment at Glen Canyon Dam. The USGS led a multiagency team to organize the winning media event, which featured the Secretary of the Interior and generated hundreds of media stories, including extended pieces on NBC's Today Show that prominently featured USGS science.

To learn more about the 2008 high-flow experiment, listen to USGS CoreCast Episode 37 at URL **http://www.usgs.gov/corecast/details.asp?ep=37**; view time-lapse videos at URL **http://www.usgs.gov/newsroom/article.asp?ID=1909**; visit the USGS Grand Canyon Monitoring and Research Center's Web site at URL **http://www.gcmrc.gov/research/high_flow/2008/**; and read a feature article by the Bureau of Reclamation at URL **http://www.usbr.gov/uc/feature/GC-hfe/**.

*(Right to left) USGS Western Regional Director **Anne Kinsinger** presents the 2008 Western Region Communicator of the Year Award to **Lara Schmit**, Communications and Outreach Coordinator with the USGS Southwest Biological Science Center, while Acting Western Region Chief of Communications **Kathleen Gohn** looks on from podium. Photograph by **Mike Diggles**, USGS.*

Coastal and Ocean Researchers Receive DOI Meritorious Service Awards

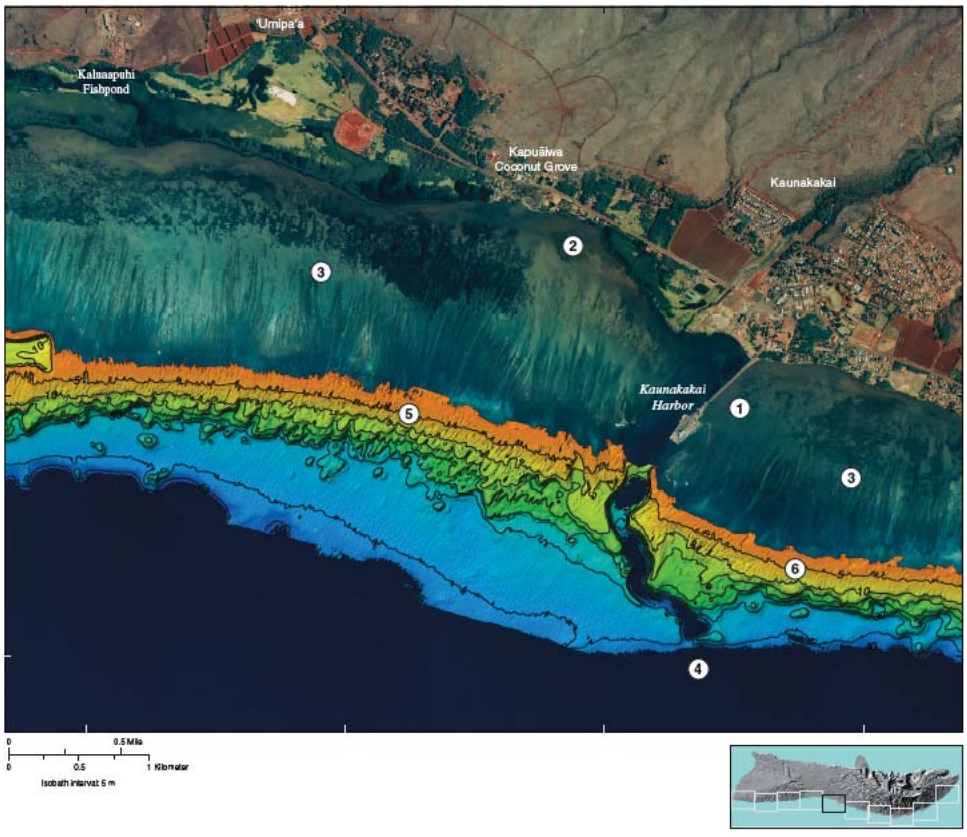
Several U.S. Geological Survey (USGS) scientists whose work includes coastal and ocean research—**Steven Amstrup**, **Pat Chavez**, **David Douglas**, and **Randy Koski**—received U.S. Department of the Interior (DOI) Meritorious Service Awards at the USGS 2008 Western Region Awards Ceremony, February 24, 2009, in Menlo Park, California. The Meritorious Service Award is the second highest Departmental honor award that can be granted to a career employee. Western Region Chief Scientist **Brian Cole** announced the awards and read the following citations:

***Steve Amstrup**. Photograph by **Mike Diggles**, USGS.*

"**Steven Amstrup** developed research techniques that are used worldwide and are instrumental in defining polar bear movement patterns and home-range size, delineating denning habitat, and estimating population size and status. Most recently, **Dr. Amstrup** led a multidisciplinary team that used highly innovative modeling techniques to forecast how worldwide polar bear populations and habitat will likely change as sea ice declines in the Arctic. Under an extremely compressed timeframe, **Dr. Amstrup's** team integrated outputs from habitat-use models and General Circulation Models to predict changes in available polar bear habitat in the 21st century. The model was of high value to the U.S. Fish and Wildlife Service and the Department of the Interior in their eventual decision to list polar bears under the Endangered Species Act. In recognition of his outstanding contributions to the U.S. Geological Survey in the field of wildlife ecology and in understanding the influences of climate change on polar bears, **Dr. Steven Amstrup** is awarded the Department of the Interior's Meritorious Service Award."

"**Pat Chavez** has been a pioneer in developing new techniques for linking satellite-borne, aircraft-mounted, and ground-based sensors to monitor the Earth. Working with the California Department of Water Resources and the Bureau of Reclamation, he provided expertise to combine information from several technologies to predict environmental changes caused by water-level declines in the Salton Sea. In this arid environment, exposed sediment becomes windborne fine particulates with a potential to adversely affect the health of half a million people living in adjacent communities. **Dr. Chavez** created wind-erosion maps that highlight the communities' differing vulnerabilities over time and space so that they can plan for their changing futures. **Dr. Chavez** has applied similar methods in a multidisciplinary study of water-erosion vulnerability in the Hawaiian Islands. On the island of Moloka'i, he used satellite images to measure changes in vegetation cover on steep hillsides. This information was used to build a model to predict future erosion rates. Resource managers used these predictions to link their management options with the likely response of terrestrial and marine ecosystems. In the Hanalei River watershed on the island of Kaua'i, **Dr. Chavez** used satellite and airborne images to provide the Hanalei Heritage River Hui, a nonprofit environmental organization, with real-time images and measures of erosion events so that unique plant and animal species could best be protected. Throughout his career, **Dr. Chavez** has been recognized for his skill in collaborating with management and scientific staff from all USGS disciplines, DOI

(Meritorious Service continued on page 20)



*View of the south Moloka'i reef and adjacent land produced by combining aerial photography and lidar (light detection and ranging) data. From chapter 2 of USGS publication "The Coral Reef of South Moloka'i, Hawai'i: Portrait of a Sediment-Threatened Fringing Reef" (USGS Scientific Investigations Report 2007-5101, URL **http://pubs.usgs.gov/sir/2007/5101/**), of which award winner **Pat Chavez** was an author.*

(Meritorious Service continued from page 19)

bureaus, State and local agencies, and nonprofit organizations. Supporters from both inside and outside the USGS continue to seek his expertise and advice on remote-sensing issues. **Dr. Pat Chavez** is awarded the Department of the Interior Meritorious Service Award in recognition of his outstanding contributions to the U.S. Geological Survey in the area of remote-sensing research."

"**David Douglas** is internationally recognized for his ability to integrate multidisciplinary data in a spatial framework to better understand landscape processes and wildlife ecology in the Arctic. He maintains one of the largest satellite-tracking databases of wildlife in the world. Integrating data on wildlife movements and population dynamics with remote-sensing data relating to variations and trends in landscape and oceanic features, he defined how landscape changes can affect wildlife populations. As the leading USGS expert on sea ice, **Mr. Douglas** and his Russian and NOAA colleagues have published nine articles on sea ice and climate. Because of his breadth of skills, **Mr. Douglas** is widely sought as a collaborator on studies related to climate change, most recently an analysis of how climate change might affect polar bears and other sea-ice-dependent species. For his outstanding contributions to the mission of the USGS, it is my pleasure to present the Meritorious Service Award to **David Douglas**."

Randy Koski *(left) receives DOI Meritorious Service Award from Western Regional Director* ***Anne Kinsinger*** *while Western Region Chief Scientist* ***Brian Cole*** *(at podium) reads the award citation. Photograph by* ***Mike Diggles****, USGS.*

"Throughout his career, **Randy Koski's** research has focused on understanding processes that create metallic sulfide mineral deposits. He is one of only a few scientists who study such deposits, which are formed at active oceanic spreading ridges, and similar ancient mineral deposits now stranded in terrestrial geologic settings around the world. In his research he used ships, deep-sea submersibles, and land-based techniques, yielding a body of scholarly works that establish critical links between many kinds of massive sulfide deposits observed on land and the processes by which they formed at the sea floor. The knowledge of ore formation resulting from his work has improved mineral exploration and development strategies in industry. Through his attention to the geochemical pathways of oxidized mine wastes, **Mr. Koski** produced a series of papers revealing how potentially toxic metals from oxidizing mine waste might affect environmental quality in nearshore and intertidal marine environments. As evidence of his international reputation, he participated on international committees with the Dahlem Workshop in Berlin in 2001 and the International Geological Congress in Florence in 2004, both of which dealt with the rapidly emerging field of marine mineral deposits. He continued his visionary leadership during his tenure as Chief Scientist of the Western Mineral Resources Team. For his exceptional contributions to the USGS in marine and terrestrial mineral resources research, **Randolph A. Koski** is granted the Meritorious Service Award of the Department of the Interior."

Polar bears on sea ice in the Arctic Ocean near Barrow, Alaska, October 1, 2008. Award winner ***Dave Douglas*** *has investigated how climate change might affect polar bears and other species dependent on sea ice. Photograph by* ***Jessica Robertson****, USGS.*

Congratulations to all the award winners!

Biologist Keith Miles Receives 2008 USGS Western Region Diversity Award in Supervisor Category

The 2008 U.S. Geological Survey (USGS)'s Western Region Diversity Award in the Supervisor Category was presented to **Keith Miles**, supervisory research wildlife biologist with the USGS Western Ecological Research Center, at a ceremony in Menlo Park, California, in February. Western Regional Director **Anne Kinsinger** presented the award to **Keith** while **Diane Garcia**, chair of the Western Region Diversity Council, read the following citation:

"It is a great pleasure that **Keith Miles** has been selected to be the recipient of the 2008 USGS Western Region Diversity Award in the Supervisor Category. **Keith**, you are being recognized for making a significant difference through your long-term efforts and commitment to developing a diverse project within the USGS. Your contribution to the values of diversity include active pursuit of diversity through a leadership style that fosters discussion and exploration of others' viewpoints and opinions, consistently hiring using Workforce Diversity Programs, and supporting staff with ongoing mentoring and encouragement. **Keith**, thank you for being an exemplary role model for all USGS managers and supervisors."

Among **Keith's** research interests are community ecology and the effects of contaminants in coastal and estuarine settings; examples include the influence of sea otter population decline on the diet of bald eagles in Aleutian Islands, and the effects of mercury contamination on waterbirds breeding in San Francisco Bay.❁

*Research wildlife biologist **Keith Miles** (center) receives the Western Region Diversity Award in the Supervisor Category from USGS Western Regional Director **Anne Kinsinger** (right), while **Diane Garcia** (left) reads the citation. Photograph by **Mike Diggles**, USGS.*

USGS Group Honored for Interdisciplinary Research on the Alaska Coastal Plain

A group of U.S. Geological Survey (USGS) scientists won a Science Strategy Success Stories award for their research on "Predicting Wildlife Response to Ecological Change Along the Arctic Coastal Plain." The award is one of three new awards given in the three geographic areas of the USGS Western Region—Pacific Southwest (California, Hawai'i, Nevada, Utah, and Arizona), Northwest (Washington, Oregon, and Idaho), and Alaska—to recognize interdisciplinary science projects that embody the spirit of the USGS Science Strategy (URL **http://www.usgs.gov/science_strategy/**).

*Alaska Area Regional Executive **Leslie Holland-Bartels** (left) accepts the Alaska Area Science Strategy Success Stories award from Western Regional Director **Anne Kinsinger** on behalf of scientists honored for their work on "Predicting Wildlife Response to Ecological Change Along the Arctic Coastal Plain." Photograph by **Mike Diggles**, USGS.*

USGS Western Region Chief Scientist **Brian Cole** announced the award at the USGS 2008 Western Region Awards Ceremony on February 24, 2009, in Menlo Park, California, where he read this excerpt from the award citation:

"In the Alaska Area, the 'Predicting Wildlife Response to Ecological Change Along the Arctic Coastal Plain' study team is given this award for exceptional support of the goals of the USGS Science Strategy through development of predictive models of how recent and ongoing Arctic landscape change influences the distribution and abundance of important bird species in a region critical to the Department of the Interior for both resource conservation and energy development."

The study team members are:

- **Chris Arp**, research ecologist, Anchorage, Alaska
- **Gary Clow**, research geophysicist, Denver, Colorado
- **Paul Flint**, research wildlife biologist, Anchorage, Alaska
- **Dave Houseknecht**, research geologist, Reston, Virginia
- **Ben Jones**, remote-sensing scientist, Anchorage, Alaska
- **Bruce Richmond**, research geologist, Santa Cruz, California
- **Joel Schmutz**, research wildlife biologist, Anchorage, Alaska

(The two other awards went to the USGS flood-response team in the Northwest Area for its work after an early January storm caused major flooding and associated avalanches, mudslides, and road closures in western Washington; and to the Great Southern California Shakeout team in the Pacific Southwest Area for its contributions to the largest earthquake drill in the Nation's history.)❁

Creators of USGS Web Site Honored for Award from National Association of Government Communicators

The creators of the U.S. Geological Survey (USGS) Web site "Coastal Habitat in Puget Sound (CHIPS)" (URL **http://puget.usgs.gov/**) were honored recently for winning a National Association of Government Communicators' 2008 Gold Screen Award of Excellence for their Web site. The National Association of Government Communicators sponsors the annual Blue Pencil & Gold Screen Awards Competition, which recognizes superior government communications products and their producers in 47 categories. Blue Pencil Award categories are designed for writing and print-related products; Gold Screen Award categories are reserved for audiovisual and multimedia products, including broadcast-related products and Web sites. The winners—the USGS Tacoma Publishing Service Center, **Bill Gibbs**, **Bobbie Richey**, and **John Clemens**—received their awards in spring 2008 and were recognized again at the USGS 2008 Western Region Awards Ceremony, held February 24, 2009, in Menlo Park, California.

*Elliott Bay, Seattle. Population growth and urbanization have changed the nearshore habitat. Photograph from "Coastal Habitat in Puget Sound (CHIPS)," USGS Fact Sheet 2006-3081, URL **http://pubs.usgs.gov/fs/2006/3081/**.*

Learn more about CHIPS from the award-winning Web site at URL **http://puget.usgs.gov/** and from a podcast interview with **Rick Dinicola**, CHIPS hydrologist, conducted by **John Clemens** for the USGS CoreCast series (URL **http://www.usgs.gov/corecast/details.asp?ID=59**).

USGS Engineer Competes in Curling Club Nationals—Team Wins Silver

By Chris Polloni

Marinna Martini, an ocean engineer at the U.S. Geological Survey (USGS) Woods Hole Science Center, and three teammates from the Falmouth, Massachusetts, area nearly achieved an upset victory at a national curling competition in March. Representing the local Cape Cod Curling Club, **Matina Heisler**, **Elizabeth Abeltin**, **Wendy Scholes**, and **Martini** captured a silver medal at the 2009 U.S. Club National Championships. Dozens of teams from across the country competed at the event, hosted by the Utica Curling

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*Cape Cod Curlers (left to right): **Wendy Scholes**, **Marinna Martini**, **Elizabeth Abeltin**, and **Matina Heisler**.*

(Curling Club continued from page 22)

Club in Whitesboro, New York. **Heisler**, the team's "skip" (captain), said that her squad went into the competition as major underdogs competing against more experienced athletes.

The team's final match, on March 14, came against the defending champions—the Duluth Curling Club from Minnesota—and was broadcast over the Internet. The Cape Cod team fell behind early in the match, then scored five points in the fourth end (10 ends is a full game) to take a 6-4 lead. The Minnesota team took control back with four points in the sixth end. The Cape Cod team tied the game in the eighth end, but Minnesota pulled ahead once more and won the gold by a final score of 10-9. In an article the next day, the *Cape Cod Times* quoted **Russ Lemcke**, president of the Cape Cod Curling Club, as saying that the team's silver win was "a big, big deal" and calling their performance against teams from across the United States "phenomenal."

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